

DISTRIBUTION OF *NOSTOC* AND *ANABAENA* (CYANOPHYTA) IN RELATION TO SOIL PROPERTIES IN THE CULTIVATED SOILS OF KARNATAKA STATE (INDIA)

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ABSTRACT. Distribution pattern of *Nostoc* and *Anabaena* was studied in different soil types and cultivation types. Soil samples where *Anabaena* was recorded had significantly higher pH and Org. C, K, Na content and significantly lower Cl content over the soils without *Anabaena*. *Nostoc* was recorded from the soils with significantly higher values of pH and PO_4 , Na and Mg content. Laterites did not appear to favour both the genera while *Nostoc* was more uniformly distributed among the soil types compared with more common appearance of *Anabaena* in sandy soils. Similarly, *Nostoc* was more uniformly recorded from dry land and rice field soils while *Anabaena* was more common in rice fields. These observations might indicate greater adaptability of *Nostoc* to soil habitats and preferential distribution of *Anabaena* in certain soil groups.

RÉSUMÉ. — Le mode de distribution de *Nostoc* et *Anabaena* a été étudié dans différents types de sols et de cultures. Les échantillons de sols avec *Anabaena* avaient une valeur du pH et une teneur en C org., K, Na plus élevées, alors que ceux dépourvus d'*Anabaena* avaient une teneur plus importante en Cl. *Nostoc* a été trouvé dans des sols avec un pH et une teneur en PO_4 , Na et Mg plus élevés. Les latérites paraissaient défavorables aux deux genres; *Nostoc* était réparti plus uniformément dans les différents types de sols tandis que *Anabaena* était plus fréquent dans les sols sableux. *Nostoc* se rencontrait aussi bien dans les terres arides que dans les rizières; *Anabaena* était plus commun dans les rizières. Ces observations pourraient indiquer que *Nostoc* a une plus grande adaptabilité que *Anabaena*. (traduit par la rédaction).

KEY WORDS : *Nostoc*, *Anabaena*, Cyanophyta, soils, India.

INTRODUCTION

A number of reports are available on the floristics of soil algae (SHIELDS and DURRELL, 1964; METTING, 1981; SUBBA RAJU, 1972; BONGALE and BHARATI, 1985). However, information on the distribution of different algal taxa in relation to soil properties is meagre. Data on the distribution of *Nostoc*

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Table I : Distribution of *Nostoc* and *Anabaena* in relation to soil properties (Mean and «F»)

Source	pH	Percentage of dry soil sample								
		CO ₃	N	PO ₄	Cl	Org.C	K	Na	Ca	Mg
<i>Nostoc</i>										
Present	7.8	0.49	0.090	0.0028	0.031	0.66	0.028	0.026	0.0140	0.0008
Absent	7.3	0.42	0.105	0.0021	0.029	0.56	0.025	0.014	0.0137	0.0006
«F» value	**	N.S.	N.S.	**	N.S.	N.S.	N.S.	**	N.S.	***
<i>Anabaena</i>										
Present	7.8	0.49	0.103	0.0028	0.015	0.66	0.031	0.036	0.0146	0.0005
Absent	7.5	0.45	0.095	0.0023	0.027	0.56	0.023	0.015	0.0140	0.0008
«F» value	*	N.S.	N.S.	N.S.	**	*	**	***	N.S.	N.S.

N.S. : Non-significant; *, **, *** : Significant at 5%, 1% and 0.1% levels respectively

Table II : Distribution of *Nostoc* and *Anabaena* in different soil groups

Soil Groups	% Occurrence		Percentage of dry soil sample						
	<i>Nostoc</i>	<i>Anabaena</i>	pH	PO ₄	Cl	Org.C	K	Na	Mg
I. Soil Types :									
Laterites	16	16	6.8	0.0017	0.034	0.60	0.023	0.004	0.0009
Red loams	42	12	6.3	0.0021	0.023	0.62	0.011	0.006	0.0010
Red sandy loams	75	56	7.7	0.0025	0.033	0.53	0.021	0.024	0.0004
Medium black sandy	65	42	8.1	0.0031	0.030	0.63	0.032	0.026	0.0008
Black clays	58	25	8.2	0.0016	0.021	0.49	0.033	0.023	0.0004
II. Cultivation Types :									
Dry lands	52	27	8.0	0.0023	0.025	0.54	0.030	0.018	0.0007
Rice fields	56	44	7.2	0.0027	0.034	0.68	0.019	0.022	0.0007
III. Irrigation :									
Rainfed	39	20	7.2	0.0019	0.024	0.52	0.021	0.010	0.0006
Irrigated	78	58	8.1	0.0033	0.036	0.73	0.032	0.033	0.0008

and *Anabaena* which are known to be the most common and important genera of Cyanophyceae among the soil algae (SHIELDS and DURRELL, 1964) is included in the present paper.

MATERIAL AND METHODS

Algal flora was studied in 143 soil samples from cultivated fields over six districts viz. Dharwad, Belgaum, North Kanara, Raichur, Bellary and Chitradurga of Karnataka State. Representative soil samples from the fields of study were taken to the laboratory. Enrichment cultures were raised from the soil samples using De's modified Beneck medium following the methods described by SINGH (1961). Both soil-water biphasic and moist cultures in duplicate were raised and the algae collected every fortnight for two months. List of algae with information on places of collection was reported earlier (BONGALE and BHARATI, 1980). Among sixteen heterocystous genera recorded, *Nostoc* (18 species) and *Anabaena* (14 species) which were recorded from 81 and 51 samples respectively, out of 143, were the most common. Soil samples were grouped according to the soil types viz. laterites (25 samples), red loams (17 samples), red sandy loams (32 samples), medium black sandy (57 samples) and black clay soils (12 samples); cultivation types (79 samples from dry-lands and 64 samples from rice fields), and irrigation types (84 samples from rainfed fields and 59 samples from irrigated fields). Soil samples were analysed for pH (1:5 soil water suspension), carbonate, chloride, calcium, magnesium, available phosphate, kjeldahl nitrogen, organic carbon, potassium and sodium following the standard methods of soil analysis quoted previously (BONGALE, 1981). Data on the physico-chemical differences between the soils with and without respective algal genera was statistically analysed following «One Criterion of Classification» (CROXTON and COWDEN, 1955).

RESULTS AND DISCUSSION

Soil samples in which *Anabaena* was recorded had significantly higher pH and Org. C, K, Na and significantly lower Cl content compared with the soils without *Anabaena*. *Nostoc* was present in soils with significantly higher pH and PO_4 , Na and Mg content compared with those in which *Nostoc* was absent. Differences with respect to other parameters studied were non-significant (Table I). Distribution frequency of *Nostoc* and *Anabaena* (as percentage of samples in which the respective genus was recorded) in soil groups is given in Table II, along with the average soil physico-chemical components of the respective soil groups. It is evident from the observations that red sandy loams and medium black sandy soils appeared to be more favourable for the occurrence of *Nostoc* and *Anabaena*, since the percentage of samples containing these algae was highest for these two soil groups. Higher pH and PO_4 and Na content of both the soil types, and K and Mg (0.0008 % of Mg) content of medium black

sandy soils correspond to the requirements of the two genera as given in Table I. Organic C content did not much differ among soil types while, Cl content of the above two soil types and K content of red sandy loams however, did not correspond with the requirements of the genera under study. In addition, black clays and red loams also did not much restrict the occurrence of *Nostoc* while *Anabaena* was less frequently represented in these two soil types. Laterites did not favour both the genera. Such a restricted distribution of *Anabaena* in sandy soils compared with greater uniformity in the distribution of *Nostoc* among soil types might indicate that *Nostoc* is less environmental specific than *Anabaena*. Further, *Nostoc* was more uniformly distributed in the two cultivation groups of soils while *Anabaena* was more common in rice field soils compared with dry-land soils, thereby supporting the above observation on the higher environmental specificity of *Anabaena* than of *Nostoc*. Irrigated field soils with higher pH, and PO_4 , Org. C, K, Na and Mg content supported greater frequency occurrence of *Nostoc* and *Anabaena* in them.

Out of 16 places of collection (BONGALE and BHARATI, 1980), the soils from 3 places totally lack *Anabaena*. These correspond to all the samples from Dharwad of Dharwad district (16 samples including 4 from rice fields and the rest from dry-lands) (BHARATI and BONGALE, 1975), Bailhongal of Belgaum district (8 samples from dry-lands) (BONGALE, 1985a) and Dandeli of North Kanara district (11 samples from rice fields) (unpublished data). This may be due to the higher chloride content of Dharwad and Dandeli soils, lower potassium content of Dandeli soils and lower sodium content of all the samples from the three places. Similarly, only three samples from Dharwad (out of 16 samples cited above) and none from Karwar of North Kanara district (unpublished) contained *Nostoc*. Comparison of physico-chemical properties of soils studied indicated that samples from Dharwad and Karwar had low phosphate and magnesium content, in addition to low sodium content of Dharwad soils.

It is of general observation that luxuriance of soil algal flora and the number of species present are closely related to available nutrient and moisture (BRISTOL, 1920; LUND, 1947; PETERSEN, 1935; TIFFANY, 1951). However, not much information is available on the possible influence of soil properties on the occurrence of specific algal taxa. Sodium is required for the growth of two common species of soil Cyanophyceae viz. *Anabaena cylindrica* (ALLEN M.B., 1956 — cf. SHIELDS and DURRELL, 1964, p. 102 —) and *Nostoc muscorum* (KRATZ and MYERS, 1955), and is also reported to be essential for nitrogen fixation by blue green algae (APTE et al., 1982) while Cyanophyceae, in general, are favoured by neutral to alkaline habitats (METTING, 1981). In the present study also, both *Nostoc* and *Anabaena* were recorded from the soils with significantly higher pH and sodium content. Some of our studies indicate that the algal genera exhibit considerable differences with regard to preferential distribution in relation to soil properties. Among the members of Oscillatoriaceae: *Lyngbya* exhibited greater adaptability when compared with *Phormidium*, *Oscillatoria* and *Microcoleus* (BONGALE, 1986a). Information on this aspect is available on certain genera of Chlorophyceae also (BONGALE, 1984, 1985b and 1986b).

Similar studies on different taxa of nitrogen fixing algae would help in selection of strains and in ascertaining the establishment of algal inoculum in different regions and in different soil groups.

It is concluded that *Nostoc* exhibited greater uniformity in its occurrence with respect to different soil types and cultivation types while, *Anabaena* exhibited its preference for sandy soils and for rice fields compared with dry-lands. Observations indicated greater environmental specificity of *Anabaena* while *Nostoc* was more adaptable to soils.

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